

Chapter 8 The Cellular Basics of Reproduction and Inheritance

A. Cell Reproduction

1. Cell reproduction is responsible for growth, the replacement of lost or damaged cells, the reproduction of many unicellular organisms, and the formation of sex cells.
2. Mitosis
3. Sexual reproduction requires the fertilization of an egg by a sperm,
4. Before either mitosis or meiosis starts, the chromosomes are replicated forming sister chromatids that are joined together at a region known as the centromere.
5. Asexual reproduction
6. Mitosis

B. Mitosis

90% of a cell's lifetime is spent in interphase. During that time the cells organic compounds and organelles are doubled and the chromosomes are duplicated (replicated).

1. Stages of Mitosis

a. Prophase-

b. Metaphase-

c. Anaphase-

d. Telophase-

e. Cytokinesis-

1) In plant cells,

2) In animal cells,

f. Mitosis produces

2. Cancer Cells

a. A cell cycle control system keeps cells at interphase until receiving a proper signal.

b. When this cycle control malfunctions a benign tumor may form. These tumors remain at the original site in the body.

c. When cancerous cells divide excessively,

d. Carcinomas are cancers of the skin or intestinal lining. Sarcomas are in bone or muscle tissue. Leukemia's are cancers of the blood marrow while lymphomas attack the lymph nodes.

3. Cancer Treatment

- a. Surgery.
- b. Radiation therapy.
- Chemotherapy.

4. Some cancer prevention methods include early detection of tumors, not smoking, exercise, avoiding excessive sun, and proper diet.

C. Meiosis and Sexual Reproduction

Human somatic (body) cells have 46 chromosomes, 22 or 23 pairs of homologs. Homologous chromosomes resemble each other in size and shape and carry the same sequence of genes controlling the same inherited characteristics. We inherit one of them from our mother and the other from our father. Females have a pair of XX sex chromosomes while the male sex chromosomes are XY. Autosomes is the term used to describe the chromosomes other than the sex chromosomes.

1. The life Cycle of Sexual Organisms

- a. The somatic cells of humans have 46 chromosomes. They have both of each of the homologs and are said to be diploid. Gametes, or sex cells have only one of each of the homologs and are said to be haploid. Human gametes have 23 chromosomes.
- b. When a sperm fertilizes an egg a
- c. Meiosis produces

2. Meiosis

There are two cell divisions in meiosis.

a. Meiosis I (reduction division)

- 1) Prophase I-
- 2) Metaphase I-
- 3) Anaphase I-
- 4) Telophase I-

b. Meiosis II (each of the meiosis I daughter cells goes through the separation of the sister chromatids)

- 1) Metaphase II-
- 2) Anaphase II-
- 3) Telophase II-

3. Genetic Variations

a. Independent Assortment-

b. Random fertilization gives even more variability to the diploid zygote.

c. Crossing over occurs when homologs exchange segments during prophase I.

d. Nondisjunction occurs during anaphase I or II when chromosomes fail to separate. Most of the time human embryos with this condition will abort.

a. Down syndrome occurs when an individual is born with 3 number 21 chromosomes (trisomy 21).

b. Abnormal numbers of sex chromosomes do not always abort. The Y chromosome has few genes and only one X chromosome is activated in any individual.

Chapter 9 Patterns of Inheritance

A. Introduction

Darwin's work left some questions. Was blending the way that traits were passed on? How to explain the many variations among species? Gregor Mendel, plant breeder and mathematician. In his day nothing was known about chromosomes or genes. Pea plants were good to work with; small and easy to raise with many easily observable traits, self-pollinating yet easily cross-pollinated and established true-breeding strains already available. With his mathematical background and complete records of numbers and kinds of offspring, he brought new insight into the significance of the statistics he accumulated.

B. Mendel and the Pea Plant

1. Pea plants produced both types of gametes (sex cells), the egg and the sperm.
2. The sperm were in the pollen and the eggs in the ovule.
3. Mendel mated true-breeding plants with contrasting traits.
4. The first generation showed only one of the contrasting traits, no blending.
5. Crossing 2 of the 1st. generation produced a second generation that characteristically had 3/4ths. Demonstrating one of the contrasting traits, and the other 1/4th showing the other trait.

C. Some Genetic Terms

1. Genes
2. Chromosomes carry many genes
3. Alleles are
4. If the organism is homozygous
5. If the organism is heterozygous (hybrid),

6. TT =
tt =
Tt =
7. The genotype is
8. The phenotype is

9. Organisms that are true-breeding produce
10. The original parents are known as the parental or P generation. A parental cross produces the first filial or F1 generation, while a cross between two of the F1 generation produces an F2 generation.

D. Mendel's Principle of Segregation- Experiments with monohybrid crosses.

1. Whenever Mendel crossed 2 hybrids
2. Mendel's principle of segregation:

E. Mendel's Principle of Independent Assortment- Experiments with dihybrid crosses.

1. When he did dihybrid crosses, he predicted the F1 plants would show both dominant alleles (all round and yellow).
2. He crossed F1 plants to see if the genes for seed color and shape would travel together.
3. A 9:3:3:1 phenotype ratio for the F2 generation established that the genes on nonhomologous chromosomes segregate independently of each other.
4. Mendel's principle of independent assortment: each pair of alleles segregates independently of the other pairs during gamete formation.
5. Test crosses can be used to

F. Human Genetic Disorders

1. Most genetic disorders
2. The disorders mentioned here are all carried on autosomes (not the sex chromosomes).
3. Examples of these disorders are albinism, cystic fibrosis PKU, sickle-cell anemia and Tay-Sachs disease.
4. Two examples of dominant disorders are achondroplasia (dwarfism) and Huntington's disease.

G. Beyond Mendel

1. Incomplete Dominance occurs when
2. Multiple Alleles and Blood Type
 - a. There are multiple alleles
AA & AO =
BB & BO =
AB =
OO =
 - b. Both A & B are dominant to O. A & B alleles are codominant in that both alleles are expressed in AB individuals.
3. Pleiotropy and Sickle-Cell Disease
 - a. Pleiotropy occurs when
 - b. Sickle-cell anemia commonly inherited by African-Americans, is an example of this condition. The allele is unusually common because heterozygotes for this condition have a greater resistance to the effects of malaria.
4. Polymeric Inheritance
 - a. Mendel studied monogenic inheritance, where there is one gene responsible for the condition.
 - b. Polymeric inheritance occurs

H. The Chromosomal Basis of Inheritance

1. The chromosome theory of inheritance states that genes are located on chromosomes and the behavior of chromosomes during meiosis and fertilization accounts for inheritance patterns.
2. Gene linkage occurs when
3. Crossing-over

I. Sex Chromosomes and Sex-Linked Genes

1. Females have XX sex chromosomes, while males, XY. The Y chromosome is $1/3^{\text{rd}}$ the length of the X and only has $1/100^{\text{th}}$ of the genes.
2. Any gene located on a sex chromosome is called a
3. The gene for maleness is located on the Y chromosome; most sex-linked genes unrelated to sex determination are found on the X chromosome.
4. Sex-linked disorders like color-blindness and hemophilia, are more common in males because they have only one X chromosome and no chance to have a normal allele on the Y chromosome.

Chapter 10 Molecular Biology of the Gene

A. Structure and Replication of DNA

1. DNA and RNA are polymers of nucleotides.
2. A nucleotide consists of a base, sugar and phosphate
3. The four bases in DNA are adenine (A), thymine (T), guanine (G) and cytosine (C). In RNA, uracil (U) substitutes for thymine.
4. The sugar in DNA is deoxyribose; in RNA it is ribose.
5. The Watson-Crick model was made up of a double helix of alternating sugars and phosphates with the bases making up the "steps" of this spiral staircase. While the phosphates, sugars and bases were bonded with covalent bonds, the two strands of DNA were held together by hydrogen bonds between the bases. A was always bonded to T and G to C.
6. Think of the sugar-phosphate chain as being the paper while the sequence of the nitrogenous bases represents the hereditary message of the DNA.
7. DNA replication begins
8. The two completed double-stranded daughter molecules are each made up of one old and one new strand

B. From DNA to RNA to Protein

1. The code for building a polypeptide
2. The sites of polypeptide production are the ribosomes in the cytoplasm.
3. Transcription is the process that:
4. Translation is the process that:
5. There are 20 amino acids and only 4 bases.
6. Transcription
 - a. A promoter signals:
 - b. RNA polymerase matches up complementary nucleotides (remember A to U) until a terminator is reached on the DNA strand.
 - c. When the RNA strand is released from the DNA it contains noncoding regions (introns) as well as coding regions (exons).
 - d. By the time the transcribed RNA leaves the nucleus,

7. Translation

- a. The players in this process are the mRNA with its chain of 3 base codons, the tRNA with their anticodons and attached amino acids, and the 2 subunits that make up the ribosome.
- b. Translation starts with the
 - c. With the start codon of the mRNA exposed (AUG), a tRNA carrying both the anticodon (UAC) and an amino acid, and the larger of the 2 units of the ribosome, coming together, the initiation phase of translation is complete.
 - d. The mRNA and the tRNA move together as a unit to another site on the ribosome allowing the next tRNA to match up with the next codon.

8. Mutations are defined as

- a. Base substitutions vary in their effect.
- b. Insertions or deletion mutations of one or more nucleotides are
- c. Mutagens may be chemical or high-energy radiation like x rays or ultra violet light. Spontaneous mutations result from errors in DNA replication or recombination.
- d. Mutations can be

C. Viruses:

1. Viruses are made up of
2. Bacteriophages (phages) are
 - a. In the **lytic cycle**, the phage DNA is injected into a bacterium and uses the cell's machinery to make more phages. When it has exhausted the resources of its host, the bacterium lyses, releasing the pathogens.
 - b. In the **lysogenic cycle**, the phage joins the bacterium's DNA and may remain dormant for generations as a prophage
3. Plant viruses have
4. Animal viruses may
5. HIV, the AID Virus
 - a. The HIV virus (human immunodeficiency virus) infects and kills several kinds of white blood cells important to the body's immune system.
 - b. The HIV is a retrovirus,
 - c. AZT is an anti-HIV drug that inhibits the reverse transcriptase.

- d. The protease inhibitors inhibit the production of HIV proteins. These drugs in combination are more effective than the individual drugs.

Chapter 12 DNA Technology

A. Recombinant DNA Technology

1. Biotechnology
 2. Recombinant DNA is
 3. Genetically modified (GM) organisms
 4. Transgenic organisms are hosts that carry DNA from a different species.
 5. Pharmaceuticals produced by transgenic organisms include insulin, a growth hormone, vaccines and a treatment for anemia.
 6. Genetically modified (GM) foods
7. Transgenic animals are much harder to produce so present techniques tend to produce a single transgenic animal and then clone it. These “pharm” animals may serve as a pharmaceutical factory (human protein for cystic fibrosis treatment), but as yet are not in our food supply.

B. Recombinant DNA Techniques

1. Overview
 - a. Plasmids are
 - b. Many copies of a bacterial plasmid and human DNA fragments are mixed together producing recombinant plasmids.
 - c. The recombinant plasmids are mixed with bacteria, some of which pick up the recombinant plasmids.
 - d. The bacteria are cloned to produce multiple copies.
 - e. The bacteria that have picked up the gene of interest are isolated and cultured.
2. Restriction enzymes are produced by
 - a. Restriction enzymes cut DNA at staggered sites creating 2 single-stranded “sticky” ends.
3. Obtaining the Gene of Interest

A genomic library includes all of the fragments of an individual’s DNA. Some techniques used to identify the fragment with the gene of interest are radioactive nucleic acid probes or using an identified mRNA of the gene of interest and reverse transcriptase to produce the gene of interest.

C. DNA Fingerprinting and Forensic Science

The use of scientific analysis of evidence for crime scene investigations and other legal proceedings is known as forensics.

1. The Polymerase Chain Reaction (PCR)
 - a. This is a technique used to amplify any segment of DNA.
 - b. The segment of DNA to be amplified is heated to separate the strands.
 - c. A heat-resistant DNA polymerase
 - d. Alternate heating (to separate the strands) and cooling under these conditions can generate 100 billion copies in a few hours.
2. Restriction Fragment Polymorphism (RFLP) Analysis
 - a. To create DNA fingerprints,
 - b. If the lengths of the fragments from the 2 DNA's are the same then a positive identification has been made.
3. Gel Electrophoresis
 - a. Restriction fragments are placed in a well in a gel apparatus.
 - b. When a current is applied, the fragments move in the gel, the shortest move the farthest. Their patterns may then be compared.

D. Genomics

Genomics is the science of the study of whole genomes.

1. The genomes of over 100 organisms have been sequenced, the majority of which are prokaryotes.
2. The Human Genome project in April of 2003 sequences the human genome of about 30,000 to 40,000 genes (3.2 billion nucleotide pairs).
3. Genomics has helped identify the sources of various pathogens and is expected to improve the quality of some crops (rice).

E. Human Gene Therapy

1. To treat a condition caused by a defective gene in a patient,
2. The gene is then inserted into a vector

F. Safety and Ethical Issues

1. Safety
 - a. Strict laboratory procedures have been set up to protect the researchers.
 - b. Strains of microorganisms to be used in recombinant experiments are genetically crippled to ensure that they cannot live outside the laboratory.
2. Controversy over GM Foods
 - a. The labeling of GM foods in the U.S. has not yet become law.

b. The European Union has suspended the importation of new GM crops.

c. Possible problems are traits of ZGM crops being picked up by other plants and new proteins being produced by GM plants.

3. Ethical Issues

a. Who has the right to know your genome?

b. Possible complications arising from gene replacements.

c. Should we be messing with genetic variations as diversity is important when environments change?

Chapter 13 How Populations Evolve

A. Charles Darwin and The Origin of Species

1. Darwin's 2 main concepts:

a.

b.

2. Ideas of Darwin's Day

a. The earth was young (6,000 years old) and populated by millions of unrelated species.

b. All living things were fixed and unchanging.

3. Lamarck and Adaptive Evolution

a. The best explanations of fossils were that life evolves.

b. He proposed that

4. The geologist Lyell stated that the earth was sculptured by geological processes over long periods of time, processes that were still going on.

B. Evidences of Evolution

1. The fossil record

2. Biogeography is the study of the geographic distribution of species. Species are found where they are because they evolved from ancestors that inhabited that region

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3. Comparative anatomy

4. Comparative embryology

5. Molecular biology established that some species have similar genes and proteins suggesting that they might have a common ancestor.

C. Natural Selection and Adaptive Evolution

1. Darwin's Theory of Natural Selection

- a.
- b.
- c.
- d.

2. "Natural selection is more a process of editing than it is a creative mechanism". An antibiotic does not create resistant bacteria, DDT does not create resistant mosquitoes; it does select the resistant individuals already in the population.

D. Darwin and Genetics

1. Darwin could not explain

2. A population is a

3. A population is the smallest biological unit that can evolve. Natural selection acts on individuals but the evolutionary impact of natural selection is only apparent in how a population varies over time.

4. Polygenic inheritance (several genes)

5. Monogenic

6. The sources of genetic variation are the process of mutation and sexual recombination.

a. Organisms with short life spans can evolve

b. Animals and plants depend mainly

c. While mutations and sexual recombination are random, natural selection and evolution are based on the environment selecting the gene combination that enhances survival and reproductive success.

7. Gene Pools

All of the genes present in the entire population comprise the gene pool. Evolution may be defined as changes in the gene pool over time. The Hardy-Weinberg principle is a way of calculating genetic frequencies based on alleles. The five assumptions of the Hardy-Weinberg principle are:

- a.
- b.
- c.
- d.
- e.

If the above 5 conditions are met, then genetic equilibrium has been reached.

8. Genetic Drift

Microevolution is a generation-to-generation change. Genetic drift is a change in the gene pool of a small population due to chance.

a. The Bottleneck Effect. Bottlenecks occur when the original population declines so much that future generations are deprived of the original variations that the large population had.

b. The founder effect occurs when a population is started by a small group that differs in allelic frequencies from the original population.

9. Gene flow occurs when new alleles are introduced into a population as a result of immigration.

10. Three Types of Natural Selection. If natural selection favors certain phenotypes, one of three modes of natural selection will be the result.

- a. Directional selection
- b. Diversifying (disruptive) selection
- c. A stabilizing selection occurs when